The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. XLIX
No. 1263

SATURDAY, SEPTEMBER 11, 1943
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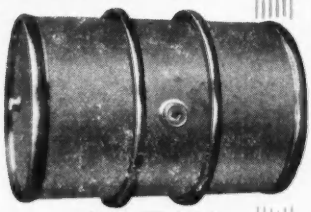

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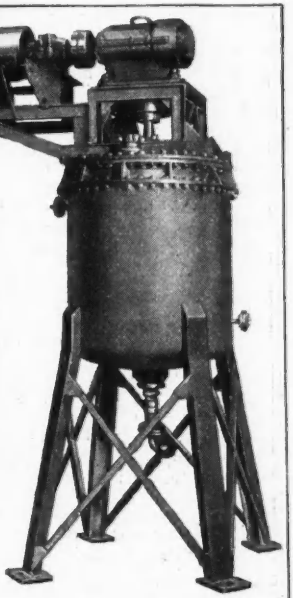

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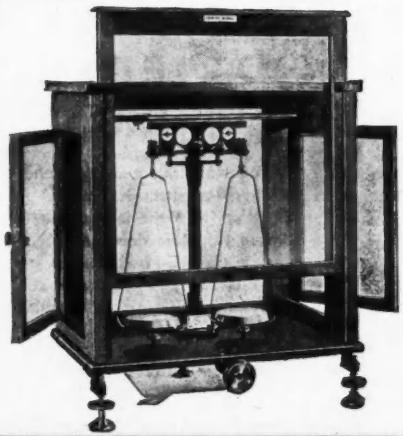

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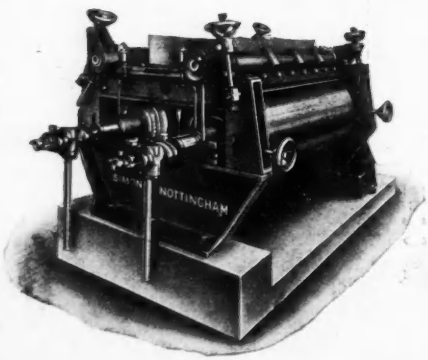

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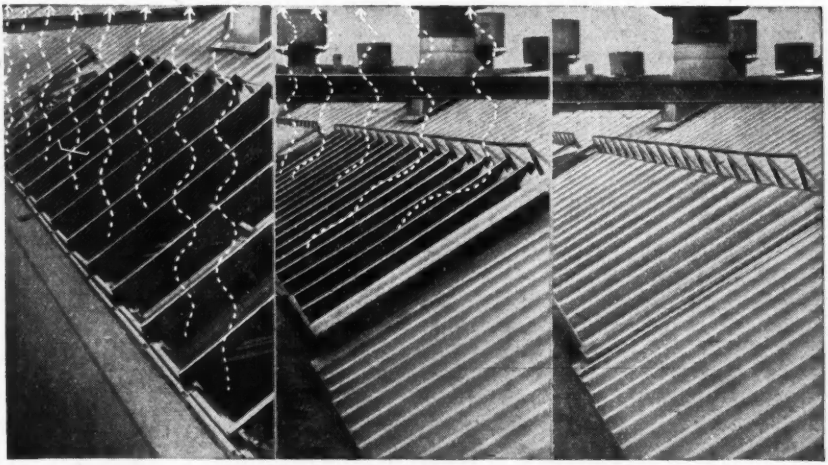

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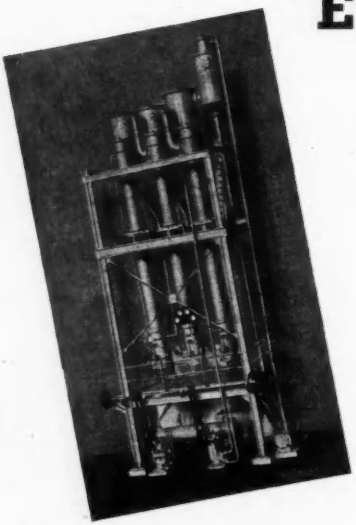

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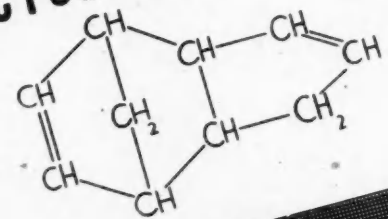

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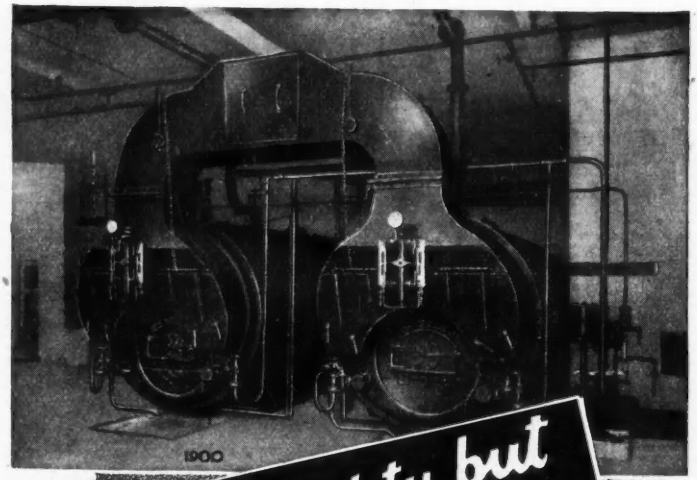

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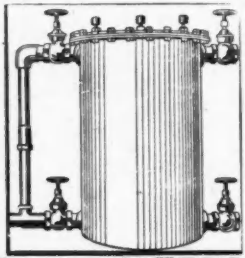

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VOL. XLIX **No. 1263** September 11, 1943 **Annual Subscription 21s. Overseas 26s.**

The Father of Modern Chemistry

IT is recorded on Robert Boyle's tombstone that he was the "father of chemistry"; but it is recorded by the common acclaim of scientific men that Antoine Laurent Lavoisier was the father of *modern* chemistry. He has gained that place not primarily by the experimental researches that he undertook, but by his skill in deducing the truth from the researches of others. Now, when we are reviewing his life 200 years after his birth on August 26, 1743, we can assess his contribution to scientific thought and perhaps amuse ourselves by speculating on the lessons to be learned from his life. Lavoisier was a Frenchman, and with the true internationalism of science he studied the works of nationals of other countries at a time when intercourse was difficult and publication very far from the easy matter that it is in the twentieth century. The great British experimentalists of the eighteenth century—Priestley, Cavendish, Black and others—contributed the raw materials from which Lavoisier erected the chemical structure that has served so well as the foundation of the modern science.

That is not to say that Lavoisier did not experiment himself. No scientific man worthy of the name—mathematicians perhaps excepted—fails to make some mark as an experimentalist. Lavoisier spent twelve years in experimenting and in making careful measurements which enabled him to revolutionise the theory of combustion and to lay the phlogiston theory in the dust of dead speculations; this work culminated in his great treatise, published five years before his death on the scaffold. In that treatise he laid the foundations of modern chemistry and threw a new light on many related sciences. How many of those who practise chemistry to-day have read it? So far as we are aware it is not readily obtainable now. It is a pity that these works of the older masters are not more accessible. Their methods lacked many of the refinements of modern scientific technique, and their deductions were made in ignorance of the quantum theory and all the modern paraphernalia of present-day physical chemistry; but there was a simplicity and directness about their work, a skilful avoidance of pitfalls, that comes as a refreshing breeze through the modern craze for research and hasty publication as a means of winning a degree or of gaining some measure of popular acclaim. Most

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of us can learn much from the works of the older chemists and physicists. To mark his bicentenary, could we not republish Lavoisier's Treatise in English translation?

It is arguable that much of Lavoisier's success was not attributable to his inherent brain power. Undoubtedly his intellect was above the ordinary and he would have stood out from his fellows in any age. But his training and the experiences of his life must have been of immense assistance to him. His father was a prominent lawyer and as a youth he was educated for the Law as a profession. That is a type of training that stands a man in good stead. It teaches him to look through the superficialities of a subject to the deeper truth that lies below. May it not be because of that training that he was enabled to see the truths that had escaped his fellows? It is an argument, for what it is worth, against narrow specialisation at too young an age. More chemists, in our opinion, are spoilt by their training than are made by it. There is only one thing to be said in favour of concentrating from early boyhood on the scientific side—that it enables examinations to be passed a little earlier and the young man can earn his living a year or two before he could otherwise have done so. But a broad education in which the youth is first taught to think as opposed to being spoon-fed with scientific "facts" and theories has its advantage in that it gives that mental balance which is so necessary. That Lavoisier was eminent in many sciences and dabbled in mathematics, astronomy, botany, mineralogy, geology, meteorology and anatomy need cause no surprise, though that is not to be taken as a precedent for the value of over-wide education in science. In those days the total sum of human knowledge in all these subjects combined was probably no more than the modern student is required to master in taking the present "pass" degree in three subjects. We are probably as wide in our knowledge as was Lavoisier. Moreover, in his day it was easier to extend the borders of knowledge, for so much remained unknown that could be discovered by simple experiment. Nevertheless, the difficulty of distinguishing the true from the false and of seeing Truth through a glass darkly was perhaps even greater in those days than to-day.

Lavoisier is an example of the scientist turned politician. Like many another before and after his day, his best work was done in his comparative youth. By forty-five he had apparently finished his scientific career, and in any event his political activities led him to the guillotine only five years later. He had made a study of the French national financial problems and of the effect of finance on agriculture. He maintained an experimental farm. It is said that his speeches and writings on the reform of taxation, on the improvement of agriculture, on education, and, on insurance for old age have a twentieth-century outlook. The penetrating intellect of this lawyer-scientist was able to foreshadow social reforms that took another century or so to bring about, and that were in the true line of democratic government. The Revolution brought the opportunity for these reforms, but the fact that he had been a member of the *Ferme*, the financial corporation which paid to the Government a fixed sum in return for the privilege of collecting taxes, made him suspect to the new Government. He was sent to execution—in modern phrase he was liquidated—because "La République n'a pas besoin de savants." So democracy slew one of those who would have helped it to make wise reforms. Perhaps the scientist, as some of our present-day scientists seem to think, has really no business to meddle in politics.

Lavoisier has been shrewdly described as "an outstanding example of the laboratory mind in action." In honouring his memory in this bicentenary year of his birth we confess to a wish that we could see more of his kind in present-day political affairs. Demos will perhaps always be predisposed to send science to the block; but the march of scientific thought and achievement will inevitably overwhelm Demos in the end and we are already seeing in the many aspects of post-war planning that it is to the teachings of science that Governments are looking for guidance of our brave new world. May our twentieth century scientists be more fortunate than Lavoisier in putting their ideas over to those who wield the power.

N_2O, by Neil Nettleton

Which way will the cat jump?

NOTES AND COMMENTS

Research and British Industry

RESEARCH is the elixir of life of industry. That is one of the telling catch-phrases which Sir Harold Hartley coins in the excellent little booklet entitled *Industrial Research—What It Means to British Industry*, which is being circulated by the Federation of British Industries. We take it to be aimed at those who are not yet research-minded, and in our opinion it is aimed dead on the bull. The examples which Sir Harold has chosen to prove his case allow of no denial. He mentions, for instance, that the gas-filled lamp developed by Langmuir represents an annual saving in the cost of domestic lighting in this country alone of £50,000,000, and that 2,000,000,000 gallons of petrol are saved each year through the improvement of the efficiency of the petrol engine by lead ethyl. If his advice to industrialists is adopted the number of such spectacular examples of the benefits brought by research will be increased a hundredfold. He recommends that firms should have at least one member of their staff with a scientific training —"no firm should be deterred from taking up research merely because it cannot afford in the first instance an expensive laboratory; it is the quality of the man that counts"; if there is a research association for their trade, they should join it now; if there is no research association, then they should urge their trade association to approach the

D.S.I.R. in order that a research association may be formed; if they have no trade association and no research association, then they should consult the Federation of British Industries. If they have no research staff and do not know how to proceed then they should apply to their research association or to the F.B.I., and if they are in a large way of business, they should consider the establishment of a research laboratory by themselves, or in collaboration with associated or kindred firms *in addition to joining the appropriate trade research association.*

Research Associations

SIR Harold does not mince words with regard to the British attitude towards research. He states that despite some outstanding exceptions there has not been in this country a general appreciation of the value of science in industry, and the amounts spent on research have been correspondingly less than in America and Germany. He finds it impossible to avoid the conclusion that, if this country is to maintain its position in the world markets, our industries must greatly increase their attention to research as soon as the progress of the war makes it possible. "There is danger in delay," he comments, "Markets once lost are not easily regained, and industrialists must be taking steps now to organise this aspect of their post-war activities." Rightly, he devotes a great deal of attention to research associations, and makes it clear that the initial step of subscribing to a research association is not costly; in many cases a small firm would be assessed for subscription at ten to twenty guineas, and not many of the larger units subscribe more than £1000 a year.

The University's Part

IN non-scientific circles this publication has evoked considerable interest, proving that Sir Harold has hit the target at which he aimed. *The Times*, for instance, devoted a leader to it, and several interesting letters resulted. One correspondent pointed out that in 1940 industry in the United States maintained 2200 laboratories with a research staff of 70,000, at an annual cost of over £60,000,000—probably about ten times as much as is spent in this country; and he based on this an argument that scientific research in this country, while in quality equal to that of any other country, is sadly behind in quantity. We are also interested to learn from this letter that the Council of Manchester University has set up a committee of scientists and industrialists to consider what developments are needed to enable the university to render services to industry equivalent to those rendered by leading universities in America, preliminary investigations indicating that it will be necessary to think in terms of trebling the Government grant to universities in order to ensure that there will be available for industry the necessary staff of trained scientists.

Ray of Hope

SCIENTISTS everywhere are doing their utmost to increase the amount of penicillin produced, though it may well be that it will never be turned out in sufficient quantities until it can be synthesised. One of the most interesting new facts about the drug which have managed to percolate through the veil of semi-secrecy that surrounds the subject is given in a letter to a recent issue of *Nature*. It records some work done by J. Ungar, of Glaxo Laboratories, Ltd., and he discloses that the efficacy of penicillin as a bacteriostatic agent is increased by the presence of another well-known drug, sulphapyridine. Tests have shown that sulphapyridine, used in quantities so small that the sulphapyridine can itself have exerted no bacteriostatic effect, can double the inhibitory action which penicillin has for a particular strain of pathogenic bacteria. For example, a solution of sodium penicillin inhibited these bacteria at a titre of 1/20,000. In the presence of sulphapyridine (added in dilutions up to 1/50,000) the solution inhibited at a titre of 1/50,000. This synergistic effect, which was first observed *in vitro*, has been investigated in live mice and some preliminary results confirming the *in vitro* experiments are recorded by Mr. Ungar. If these tests can be fully confirmed the discovery opens up the possibility that the small quantities of penicillin now available for medical practice might be made to go a lot farther.

Introduction to Chemurgy

A Growing Industry Based on Plant Products

by M. K. SCHWITZER

THE intensive development of agriculture in this and other countries has drawn the attention of scientists and economists to two major problems. One is the maintenance of soil fertility, and the other the economic disposal of regional and seasonal surpluses of farm crops. To keep the soil fertile all ingredients taken from the soil must be returned. Fertilisers and crop rotation help to achieve this, but that is not sufficient. In many parts of the Continent it has been usual to combine large farms with distilleries and to spread sugar factories over the beet-growing districts. Potatoes, cereals and sugar beet were transformed into alcohol or sugar respectively. The slop, pulp and molasses were used to fatten cattle and to feed the dairy herds, the animal manure being returned to the soil, thus completing the highly desirable closed circuit. In principle, this method could be called " chemurgic " farming It had not only the advantage of producing bread, meat, milk, sugar and alcohol most economically, but it also contributed effectively towards keeping the soil fertile.

Surpluses

A feeling amongst farming populations all over the world that the present boom in their products might turn into a slump, as soon as the vast relief programme outlined at Hot Springs has been completed, is unjustified. Chemurgists regard the products of agriculture as raw materials vital to industry. Surpluses of certain crops at certain periods and in certain districts are unavoidable, but all such surpluses could be usefully absorbed by industry. During the period of restrictive economy between the last two wars, many surpluses were destroyed. This meant waste of all the production costs, but more than that, the products were thereby rendered more expensive, the consumer ultimately paying for the waste. By creating a continuous industrial demand for agricultural products, science and chemical engineering will not only help to maintain the price of food at a low level, but also render their greatest contribution to agricultural practice and to farmers' security. Once the principles of chemurgy are fully understood and adopted, even the vastest " food-for-all " programme will appear insignificant when compared with the great potential capacity of an industry that utilises farm crops as its raw materials.

Many chemurgic principles have already found practical application for many years. The significance of this, however, was only fully realised during the last great slump when in the U.S.A. large quantities of surplus crops impoverished whole districts and turned a large part of the farming population into a desolate mass deprived of any purchasing power, while at the same time " economists " were considering it inevitable that in the Far East more than a million people should be dying from hunger each year.

Birth of the New Science

The word " Chemurgy " was coined in 1934 by Dr. William J. Hale, research consultant of the Dow Chemical Company of America, in his book " Farm Chemurgic." It is derived from the Greek " ergon," which means work, and " Chemi " or " Khem," which was the name given to Ancient Egypt by neighbouring nations, derived from Egypt's hieroglyphic name " Qemi," meaning dark soil or black land. As far back as 3000 B.C. the Egyptians were chemical technologists and thus chemistry became the name for the " art of the black country." Hence, Chemurgy might best be translated as " chemistry at work " and its function is to discover new ways and means of using farm crops as raw materials for producing goods other than food and clothing.

A practical beginning was made in May, 1935, when 300 manufacturers, scientists and farmers met in Dearborn, Mich., U.S.A., to discuss how vast rural areas could be revitalised by new chemurgic industries and how to deal with food surpluses and wood waste.[1]

The items dealt with included soya beans, tung trees, cellulose, cotton, slash pine, sugars, starch and power alcohol. The first "chemurgic farm paper" was founded, and two years later half a million dollars were given by the Rackham fund to Michigan State College for chemurgic research. Simultaneously, a movement began to strengthen scientific and industrial aspects of farming. In 1938, President F. D. Roosevelt and Vice-President Wallace, himself a farmer, created the Bureau of Agricultural Research and Technology. In the same year the Agricultural Adjustment Act was passed and four Regional Farm Industrial Laboratories were set up, each staffed with about 200 research workers, financed with a million dollars annually, and supervised by Dr. H. G. Knight, chief of the Bureau of Chemistry and Soils. To-day, there are no less than thirty regional chemurgic councils in the U.S.A. and the National Farm Chemurgic Council comprises more than 150 corporations (each of which contributes $2500 annually) and 1600 individual members. Annual meetings are held in different towns and the topics discussed vary from breeding hybrid poplars capable of an annual growth of twelve feet in height and 1½ in. in diameter, to commercial food dehydration plants, and from non-crystallising corn syrup to the "farm-grown" motor car.

Attention was drawn to the potentialities of chemurgy in England, particularly by the Moncure Conway Memorial lecture of Professor Hogben entitled "The Retreat from Reason," and the 1937 William Mather lecture by Sir Harold Hartley, while in Canada the Dominion Chemurgic Association was founded in 1939 to assist farmers and industrialists in all chemurgic problems. In recent years chemurgy has developed with vigorous strides. Many scientists hold that this new branch of science may yet have big surprises in store.

Power Alcohol

When Dr. Hale published his "Prosperity Beckons," he gave it the subtitle of "The Dawn of the Alcohol Era," thereby drawing attention to the prominent place which the alcohol industry had quickly conquered for itself. Ethyl alcohol was first introduced as a motor fuel in some countries as a partial substitute for imported petrol. The consequent economy in foreign exchange justified to a certain degree a subvention for agriculture. The creation of a powerful agricultural alcohol industry served the dual purpose of saving foreign exchange and stabilising the economic condition of the farmer.

Initially, only a very small percentage (approximately 5 per cent.) of 96 per cent. ethyl alcohol was mixed with petrol; higher proportions would have caused loss in power output. Later research showed that better results and a higher performance could be achieved by mixing approximately 60 per cent. of petrol with 25 per cent. of benzol and 15 per cent. of alcohol. New processes for the dehydration of alcohol were developed in 1923 by Backus in U.S.A., Guinot in France, and by German scientists during their country's drive for self-sufficiency. In 1939 the daily world production of absolute alcohol was upwards of 900,000 gallons. By mixing absolute alcohol, instead of 96 per cent. spirit, with petrol, the technical problem of avoiding power loss was overcome. A very thorough investigation of this subject was carried out and published by the Empire Motor Fuels Committee some few years ago. An interesting new development in the production of ethyl alcohol has just been reported by P. S. Singleton, of Everett, Mass. Granular wheat flour is being used with good results as raw material for alcohol and with minimum of capital expenditure on machinery. The dual feature of the granular flour programme is that a use is found for idle milling capacity, without interference with flour grinding.

Butyl Alcohol and By-Products

During the last war the Weizman fermentation process provided the vital raw material, acetone, for the explosive industry; the by-product, butyl alcohol, then had only limited application in industry. Recently, further attention has been drawn to this process. Butyl alcohol is obtained by anaerobic fermentation of starch-containing matter; 100 lb. of maize, for instance, yield approximately 16 lb. of butyl alcohol besides such valuable by-products as acetone, ethyl alcohol, hydrogen, carbon dioxide and a cattle food rich in proteins and vitamin B. The butyl alcohol can then be

dehydrated over activated alumina, yielding *n*-butene. A part of the latter can be converted into iso-butene which is polymerised with the remainder of *n*-butene to iso-octene. The hydrogenation of iso-octene gives iso-octanes. The great importance of high performance aviation spirit produced from farm crops is therefore evident. Especially those countries, such as Canada, South Africa, Brazil, and Czechoslovakia, with a developed agriculture but practically no mineral oil, would greatly benefit from home-produced chemurgic high-octane motor fuel.

The use of alcohol as motor fuel has only just started in many countries. It has rapidly increased during the war and nobody can foretell the speed and extent of its growth. The fractions of mineral oil and natural gas from which C_3 and C_4 compounds are now produced are limited. The demand for such compounds is ever increasing and it might be expected that supplementation of this range by butyl alcohol derivatives will gain importance.

Synthetic Rubber

More recently the great demand for plastics and synthetic rubber has opened a new field of use for both ethyl and butyl alcohol. When in 1939 Prof. Hale's " Forward March " became a best seller in America, he may not have foreseen the great importance alcohol would gain in the rubber and plastics programme. When he stated that " agricultural alcohol holds the greatest power over human civilisation because it is one chemical entity endowed with the widest range of chemical activity and versatility," he possibly did not expect that as early in June, 1943, approximately one-third of the synthetic rubber programme in the United States would choose agricultural alcohol as a raw material, thus absorbing the vast surplus stocks of grain.

In this connection, it is interesting to note that it has been estimated[2] that " if Great Britain were to manufacture only enough synthetic rubber to provide the raw material for her own industry, something like 400,000 acres of potatoes a year would be absorbed, and this would go a long way to solve the problems of some of our arable farms. The residues after alcohol extraction are of considerable financial value for the farmer." Dr. H. Barron dealt with a similar subject in a most important lecture, "Agriculture and Plastics," given at Southampton in June.[3] Though in the specific case of rubber there is the possibility of processing it either directly from plants (*e.g.*, hevea, guayule) or indirectly via agricultural alcohol or from oil or coal and limestone, there are many aspects that show chemurgic production of rubber to have a great advantage over other methods of production.

Casein and Soya Plastics

In the field of plastics, unlimited scope for chemurgy can be expected. Already in the United States a very large proportion of agricultural butyl alcohol is being converted into dibutyl phthalate —one of the most important plasticisers. During the last few years, developments have taken place in the cellulose industry from which it may be anticipated that in the immediate post-war period acetates will be replaced to a large extent by butylates, or by mixtures of both, for which large quantities of butyric and propionic acids will be required. Both acids can be produced by direct fermentation methods, or alternatively, butyric acid can be derived from butyl alcohol.

The production of casein plastics was one of the first purely industrial utilisations of an agricultural product. The wide scope these plastics have found, in particular in the fancy goods industry, is well known. In this connection, the production of synthetic wool from casein is worth mentioning.

Finally, it might rightly be expected that the soya bean will play an important rôle in changing the shape of things to come. For 5000 years the soya bean was one of the basic staple foods in China and Japan. It was introduced to the southern States of the U.S.A. in 1804. Up to the middle 1930's the acreage under soya beans was negligible. The 10 million acres planted in 1942 represented an increase of 83 per cent. over 1941, and produced a record yield of 210 million bushels. The soya bean contains twice the protein of meat, twice the calcium of milk and more than twice the mineral content of wheat and is a perfect natural food. Its complex oil and protein content can provide inexhaustible uses for industry; it can be pressed into

a plastic and spun into cloth; cracked like petroleum for paints and varnishes; and refined for edible oil and soap. The pre-war research work carried out by the Ford Motor Company, which developed a plastic from soya beans as a basic material suitable for the production of motor car bodies, is well known.

Significance of Chemurgy

Mr. H. Ickes, U.S. Petrol and Solid Fuels Co-ordinator,[4] revealed recently "that in meeting the declining number of petrol deposits discovered in recent years, synthetic rubber and plastics industries will have to look somewhere else for raw materials," while Lord Cherwell stated in the House at the end of July that "the survey of our coal resources now proceeding will enable us to judge how soon our scientists will have to discover another form of energy" and he invited sound proposals for industrial research extension of that topic.[5] While mineral oils and coal are exhaustible, farm crops will exist as long as man assists nature. It is the most important task of chemurgy to preserve our inherited mineral wealth by enabling us to use that wealth sparingly by substituting for it crops that are renewable each year.

Much has already been achieved, yet we are still only at the beginning of our experience in soil fertilisation, cultivation of crops, and breeding of animals and plants. Promising results have been achieved by artificial insemination. Vernalisation of winter cereals has reduced the period between sowing and harvesting from 9 months to 60 days, thus opening vast semi-arctic districts to cultivation. The adaptation of all such methods points to the unlimited potentialities of soil productivity. While the average world wheat yield is about 14 bushels per acre, 60 to 70 bushels of wheat per acre have been harvested in many parts of England in the present 1943 harvest, One day even hydroponics (soilless culture) might be usefully employed for growing food or industrial crops on a large scale. This would certainly be a welcome innovation to countries with small arable acreage like Norway, or with large populations like England, or wherever adverse natural conditions prevail as in semi-arctic districts. There is scarcely a day without news of new developments in these directions. Their practical applications after the war might be overwhelming. Industrial biology is in its infancy and promises to open the door to surprising wealth. Great successes have already been achieved by the activated sludge process which provides for the conversion of the sewage sludge of big towns into a valuable fertiliser.

The more the farmer improves the quality of his crops and steps up their yield, the more does he profit from agricultural industries and the better balanced becomes the national and world economy. The incidental move of an important part of industry into hitherto purely farming districts will also intrinsically contribute to the solution of the problems of location of industry.

The dream of mankind to use solar energy, air and soil most efficiently for production of food, clothing and industrial materials is thus coming nearer to realisation. Coal and oil, which for a long time were the basis of our chemical industry are giving way, to an increasing extent, to chemurgic industry. Instead of using up the stored energy from fossil flora and fauna in coal and oil, we take a short cut and produce industrial materials from annually replaceable crops. We thereby save our capital resources, being able to use coal and oil with more care and less waste, and only for purposes where they cannot be replaced by other materials. We can therefore live on recurrent revenue without drawing on capital. Close control of plant growth will enable us to multiply the variety of crops and improve their quality and quantity. Except for their mineral content of 2-3 per cent., plants depend on moist air and sunshine, of which there are unlimited stores. Hence chemurgy can lead to unlimited wealth for mankind.

REFERENCES

1 CHRISTY BORTH, *Pioneers of Plenty, The Story of Chemurgy*, 1942.
2 *Rubber Age*, April, 1943, p. 38.
3 *British Plastics*, July, 1943.
4 *Chemical Age*, 1943, **49**, p. 90.
5 *Ibid.*, 1943, **49**, p.90.

Finding new uses for sugar will be one of the aims of the Sugar Research Foundation, set up in America as a non-profit organisation to conduct research and distribute factual information about sugar in diet.

A Substitute for Superphosphate

Rock Phosphate Fused with Olivine

AT the recent meeting of the American Chemical Society, J. H. Walthall and G. L. Bridger, of the Tennessee Valley Authority, described how a mixture of rock phosphate and olivine can be fused to yield a product with a high proportion of soluble P_2O_5. The following account is condensed from their paper as printed in *Ind. Eng. Chem.* (1943, *35*, 7, p. 774).

To make the P_2O_5 in rock phosphate readily available to plants, it is necessary to break up the structure of fluorapatite, the principal phosphatic component of rock phosphate. [The availability of P_2O_5 in fertilisers to plants is usually estimated by its solubility in solvents such as neutral ammonium citrate solution[1] and citrated ammonium nitrate solution.[9]] The fluorapatite structure may be broken either by removing the fluorine from the rock phosphate or by treating rock phosphate chemically without effecting substantial removal of fluorine. For example, rock phosphate may be defluorinated by calcination with silica in the presence of water vapour at temperatures higher than 1300° C.[2,11] or by treating the molten rock phosphate with water vapour.[3] Examples of chemical treatment of rock phosphate without complete defluorination are the manufacture of superphosphate, in which rock phosphate is treated with either sulphuric or phosphoric acid and most of the fluorine in the rock phosphate remains in the superphosphate,[7] and the fusion of rock phosphate with addition agents to make products high in P_2O_5 solubility, but retaining most of the initial fluorine. Both acidulation and fusion with addition agents break up the fluorapatite structure of rock phosphate.

Fusion Processes

Some information has been published on processes for the fusion of rock phosphate with addition agents to make its P_2O_5 soluble without removal of fluorine. Wolters[17] described a process for making a product of high P_2O_5 solubility by the fusion of rock phosphate with alkali and alkaline earth silicates. For example, by fusing a mixture containing 1.00, 0.60, and 0.30 part of rock phosphate, alkaline earth silicates, and alkali silicates, respectively, he obtained a product with an almost completely soluble P_2O_5 content. Also, by fusing a mixture of 1.00, 0.80, and 0.84 part of rock phosphate, calcium carbonate, and silica, respectively, Wolters found that the P_2O_5 was almost completely soluble but that considerable loss of P_2O_5 by volatilisation occurred. Giese and Wolters[4] obtained a patent on the preparation of soluble phosphates by fusing rock phosphates with silicates, and cooling the melt in a blast of steam and air; they used the proportions (a) 1.00 part rock phosphate, 0.45 part sodium bisulphate, 0.28 part limestone, and 0.27 part silica, or (b) 1.00 part rock phosphate and 0.45 part sodium-calcium silicate. Presumably the kinds and proportions of silicates are the same as those stated in the earlier Wolters' patent.[17] Prjanischnikow[10] described the preparation of a product of high P_2O_5 solubility by the fusion of 1.00 part of rock phosphate with about 0.5 part of sodium carbonate. Other processes for the fusion of rock phosphate with various addition agents are those of Wiborgh[16], Heskett[5], and Schleede, Meppen, and Scheel.[13] The chief disadvantages of these processes are the excessively large proportions of inexpensive addition agents required with resultant high fusion costs and low P_2O_5 concentration in the products; or the need for expensive addition agents such as sodium carbonate.

A number of processes[12,14,15] for the calcination of rock phosphate with addition agents, with or without defluorination, have been used in Europe, but have not been adopted in the United States.

Preliminary Investigations

Preliminary investigations indicated that the fusion of rock phosphate with magnesia and silica would yield a product high in P_2O_5 solubility although retaining a large proportion of fluorine. For example, a product was prepared by fusing a mixture of 0.28 lb. of magnesia and 0.21 lb. of silica per lb. of rock phosphate, and quenching the melt in water; the P_2O_5 in this product was completely soluble in citrated ammonium nitrate solution. Other experiments showed that, if such a mixture were either calcined to incipient fusion in a rotary kiln or sintered by mixing with coke and burning, only 15 to 20 per cent. of the P_2O_5 in the products was soluble in citrated ammonium nitrate solution.

A process for fusion of rock phosphate with magnesia and silica would have advantages over other rock phosphate fusion processes, if the proportions of magnesia and silica required were not excessive; the raw materials would be inexpensive, and defluorination, which requires special types of furnaces and additional fuel over that required for fusion, would be obviated. Such a process might be practicable in the Tennessee Valley, because large deposits of high grade olivine, a mineral magnesium silicate, are found there. In North Carolina and Georgia, in or adjacent to the Tennessee River watershed, estimates show about a

TABLE I. COMPOSITION OF RAW MATERIALS

Material	Composition, Per Cent. P_2O_5	CaO	MgO	SiO_2	Fe_2O_3	Al_2O_3	F
Rock phosphate A	33.3	47.1	...	6.3	2.8	1.8	3.63
Rock phosphate B	33.2	46.4	...	5.4	2.3	...	3.56
Magnesite brick	...	3.4	86.5	5.7	5.9	...	...
Silica	...	...	...	96	...	...	...
Olivine	...	0.9	45.0	43.9	8.1	...	...

billion tons of dunite containing more than 40 per cent. magnesia and 230 million tons of olivine averaging 48 per cent. magnesia.[8] All the large deposits of olivine are accessible to rail or road transport.

A systematic study was therefore made to determine the proportions of magnesia, silica, and olivine required for a product of high or complete P_2O_5 solubility when these materials are fused with rock phosphate.

The chemical compositions of the raw materials are shown in Table I. The rock phosphate was high-grade Tennessee brown rock phosphate sand. Ground magnesite brick was the source of magnesia, and silica pebble the source of silica. The olivine was a commercial product from Spruce Pine, N.C. Two electric furnaces were used in the course of the investigation. One was a Detroit rocking indirect-arc furnace, lined with silica brick and operated at about 25 kW. The other was a single-electrode direct-arc furnace lined with carbon and operated at about 90 kW. The charges to the indirect-arc furnace weighed about 25 lb.; those to the single-electrode furnace, about 150 lb. The single-electrode furnace was equipped with a quenching system, consisting of a trough through which a high-velocity stream of water was directed. The fusion procedure consisted in mixing the desired proportions of constituents, ground to −4 mesh or finer, melting the mixture in one of the furnaces, and cooling the melt rapidly by water quenching. When the indirect-arc furnace was used, the melt was poured into a pan of water; when the direct-arc furnace was used, the melt was allowed to flow into the stream of water of the quenching system. About 30 minutes were required to melt a charge in either furnace. The temperature of the melts as they poured from the furnaces was 1450° to 1550°C.

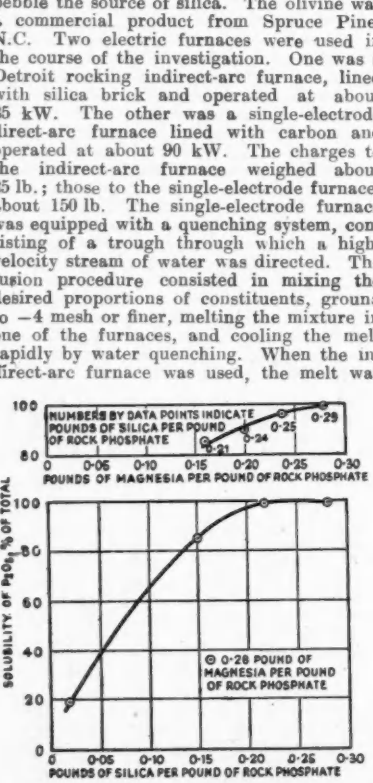
NUMBERS BY DATA POINTS INDICATE POUNDS OF SILICA PER POUND OF ROCK PHOSPHATE
0·21
0·24
0·25
0·29
POUNDS OF MAGNESIA PER POUND OF ROCK PHOSPHATE
SOLUBILITY OF P_2O_5, % OF TOTAL
⊖ 0·28 POUND OF MAGNESIA PER POUND OF ROCK PHOSPHATE
POUNDS OF SILICA PER POUND OF ROCK PHOSPHATE

Fig. 1.—A and B.

Soluble P_2O_5 in the products was determined by the MacIntire-Shaw-Hardin method,[9] which employs a citrated ammonium nitrate solution as the solvent.

Two series of fusions were made to determine the proportions of magnesia and silica required for complete solubility of P_2O_5. In the first series (Table II-*A* and Fig. 1-*A*), from 0.21 to 0.29 lb. of silica per lb. of rock phosphate was used in each fusion, and the proportion of magnesia was varied from 0.16 to 0.28 lb. per lb. of rock phosphate. It was found that 96 per cent. of the P_2O_5 in the product was soluble when 0.24 lb. of magnesia and 0.25 lb. of silica per lb. of rock phosphate was used, and that essentially complete solubility of P_2O_5 was obtained when 0.28 lb. of magnesia and 0.29 lb. of silica per lb. of rock phosphate was used. The proportion of silica in this series was not constant because the fusions were carried out in a silica-lined furnace, and the amount of silica dissolved from the lining could not be controlled. However, all the products made in series *A* contained more than the minimum proportion of silica required for complete P_2O_5 solubility, as indicated in the next series.

In the second series (Table II-*B* and Fig. 1-*B*), carried out in a carbon-lined furnace, the magnesia was kept constant at 0.28 lb. per lb. of rock phosphate, and the silica was varied from 0.02 to 0.28 lb. per lb. of rock phosphate. It was found that 0.22 lb. of silica per lb. of rock phosphate was required for essentially complete P_2O_5 solubility, when 0.28 lb. of magnesia per lb. of rock phosphate was used.

In most of these runs the amount of fluorine volatilised from the rock phosphate was between one-fourth and one-third of that initally present. In Table II-*B*, the fluorine volatilisation increased with increasing proportions of silica.

Since magnesium is a desirable plant nutrient, the solubility of the magnesium in one of the rock phosphate-magnesia-silica fusion products was determined. The availability of magnesium in selectively calcined dolomite to plants has been judged by its solubility in neutral ammonium citrate solution[8]; therefore this solution was used for

the present analysis. Ninety per cent. of the magnesium in product PS57 (Table II), which contained 18.5 per cent. of magnesium oxide, was soluble in neutral ammonium citrate solution. Thus most of the magnesium in the rock phosphate-magnesia-silica fusion products is readily available to plants.

Since the foregoing experiments indicated that the proportions of magnesia and silica required for high P_2O_5 solubility were not excessive, and that the ratio of magnesia to silica required was approximately the same as that of magnesia to silica in olivine, it appeared that olivine would be an economical material for fusion with rock phosphate. Results of a series of fusions are shown in Table III and Fig. 2. To obtain 94 per cent. P_2O_5 solubility of the product, 0.46 lb. of olivine per lb. of rock phosphate was required; to obtain 98 per cent. P_2O_5 solubility, 0.62 lb. of olivine was necessary. These results are in good agreement with the fusions of rock phosphate with magnesia and silica (Table II). The amount of fluorine volatilised was about the same as that observed in fusions with magnesia and silica.

The volatilisation of P_2O_5 in the fusions of rock phosphate with olivine, as determined by the difference in P_2O_5/CaO ratio of the furnace charge and of the product, was usually about 5 per cent. and was as high as 13 per cent. in one case. This volatilisation was presumably due to reduction by the carbon furnace lining and carbon electrodes. Consequently, a fusion was made in which a mixture that contained 0.60 lb. of olivine per lb. of rock phosphate was charged continuously into the direct-arc furnace for eight hours; the furnace was tapped at 30-minute intervals. With this method of operation, the furnace always

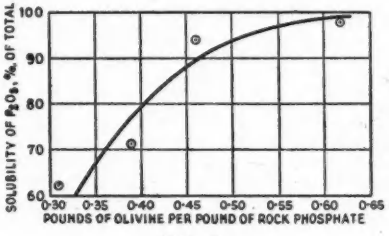

Fig. 2.

contained a layer of unfused charge above the molten material; thus any vapours or fumes liberated from the melt rose through the layer of unfused material, whereas in the batch experiments the upper half of the furnace was empty. Analyses of the product from the fusion in which continuous charging was used indicated that the P_2O_5 loss was only 1 per cent.; the fluorine volatilisation was 11 per cent. This experiment indicates that there would be no appreciable P_2O_5 loss from an electric carbon-lined furnace designed so that the unfused part of the charge could serve as an absorbent for liberated phosphorus or P_2O_5. Also, it is likely that the P_2O_5 losses resulting from fusion of the mixture in a furnace not lined with carbon would be small.

To determine whether high solubility of P_2O_5 could be obtained with smaller proportions of olivine than those required for high solubility in the above fusions, if larger proportions of silica were used, two series were run in which both olivine and silica were fused with rock phosphate. In the first (Table IV-*A*), 0.31 lb. of olivine per lb. of rock phosphate was used. The solu-

TABLE II. EFFECT OF MAGNESIA AND SILICA ON P_2O_5 SOLUBILITY IN FUSION OF ROCK PHOSPHATE WITH MAGNESIA AND SILICA

Fusion No.	Lb. Addition Agent per lb. Rock Phosphate A: MgO	SiO_2	Composition of Product, %: P_2O_5	SiO_2	F	Soly. of P_2O_5, % of Total	F Volatilised, % of Initial
A. Magnesia Content Varied (Indirect-Arc Furnace)							
PS66	0.16	0.21*	25.4	21.4	1.86	85	33
PS65	0.20	0.24*	24.3	22.2	1.10	90	58
PS64	0.24	0.25*	23.8	22.6	1.70	96	34
PS57	0.28	0.29*	21.6	23.7	1.71	99	30
B. Silica Content Varied (Direct-Arc Furnace)							
PSE5	0.28	0.02	27.2	8.4	2.37	19	20
PSE6	0.28	0.15	23.4	18.3	1.92	85	25
PSE7	0.28	0.22	22.2	21.3	1.72	100	29
PSE8	0.28	0.28	20.9	25.5	1.58	100	31

* Calculated from percentage of silica in product.

TABLE III. EFFECT OF OLIVINE PROPORTION ON P_2O_5 SOLUBILITY (DIRECT-ARC FURNACE)

Fusion No.	Lb. per lb. Rock Phosphate B: Olivine constituents: Olivine	MgO	SiO_2	Composition of Product, %: P_2O_5	CaO	MgO	SiO_2	F	Soly. of P_2O_5, % of Total	F Volatilised, % of Initial
PSE11	0.31	0.14	0.13	23.5	38.3	10.5	18.6	2.12	62	27
PSE14	0.39	0.17	0.17	24.5	35.9	12.1	19.4	1.84	71	33
PSE10	0.46	0.21	0.20	22.8	34.9	14.3	22.0	1.87	94	29
PSE9	0.62	0.28	0.27	21.3	31.5	17.4	23.4	1.71	98	28

TABLE IV. EFFECT OF MAGNESIA-SILICA PROPORTIONS ON P_2O_5 SOLUBILITY IN FUSION PRODUCTS OF ROCK PHOSPHATE WITH OLIVINE AND SILICA (DIRECT-ARC FURNACE)

Fusion No.	Lb. per lb. Phosphate Rock: Si pebble	Olivine and Si Pebble Constituents: MgO	SiO₂	Composition of Product, %: P_2C_5	CaO	MgO	SiO_2	F	Soly. of P_2O_5,F Volatilised, % of Total	% of Initial
			A. 0.31 lb. Olivine per lb. of Rock Phosphate B							
PSE11	... 0.00	0.14	0.13	23.5	38.3	10.5	18.6	2.12	62	27
PSE12	... 0.14	0.14	0.27	21.9	35.6	9.4	26.7	1.17	81	57
PSE13	... 0.28	0.14	0.40	18.6	34.2	8.1	32.4	1.37	80	47
			B. 0.39 lb. Olivine per lb. of Rock Phosphate B							
PSE14	... 0.00	0.17	0.17	24.5	35.9	12.1	19.4	1.84	71	33
PSE15	... 0.11	0.17	0.27	22.5	34.5	11.3	24.6	1.80	57	31
PSE16	... 0.25	0.17	0.40	20.8	31.8	11.0	30.1	1.09	81	55

bility of P_2O_5 could be increased from 62 to 81 per cent. by using 0.14 lb. of silica per lb. of rock phosphate in addition to the olivine, but no further increase in solubility of P_2O_5 was obtained when 0.28 lb. of silica per lb. of rock phosphate was used in addition. In the second series (Table IV-*B*), 0.39 lb. of olivine per lb. of rock phosphate was used. The solubility of P_2O_5 could be increased from 71 to 81 per cent. when 0.25 lb. of silica per lb. of rock phosphate was used in addition to the olivine. Because products having P_2O_5 solubility higher than 81 per cent. were not obtained, and because the amount of silica needed even for this solubility was relatively large with attendant decrease in the P_2O_5 content of the product, it appears better to use no additional silica for the fusions.

Pot Culture Tests

A sample of product PSE10 (Table III), ground to −100 mesh, was subjected to pot culture tests in the greenhouse. This product had been made by the fusion of a mixture containing 0.46 lb. of olivine per lb. of rock phosphate and contained 22.8 per cent. P_2O_5, 94 per cent. of which was soluble in citrated ammonium nitrate solution, as compared with 2.2 per cent. for the raw rock phosphate. The test crop was Sudan grass. Within the limits of accuracy of the tests, the rock phosphate-olivine fusion product appeared to be practically as effective as the two superphosphates. On both soils the rock phosphate-olivine fusion product and the defluorinated fused rock phosphate were equally effective.

The experiments indicate that the P_2O_5 in rock phosphate can be made available to plants by fusion of the phosphate with proportions of magnesia and silica, or of olivine, that are relatively small compared with the proportions of alkaline earth silicates reported as necessary by previous investigators, and without removal of the major portion of the fluorine of the rock phosphate. A process for making phosphatic fertiliser by fusion of rock phosphate with olivine would have a number of advantages over other processes. In contrast to processes for making superphosphate, expensive acid is not required. Its advantage over processes for making metaphosphates is that expensive elemental phosphorus is not needed. In contrast to processes for making defluorinated fused rock phosphate, it is not necessary to remove substantially all of the fluorine from the rock phosphate, a difficult and expensive task. Its advantages over other fusion processes in which P_2O_5 solubility is obtained by addition agents without defluorination are that the agent required in the present process is inexpensive and the amount required is relatively small. These advantages of the rock phosphate-olivine fusion process should result in lowered costs of production of available P_2O_5. An advantage of the rock phosphate-olivine fusion product is that it contains soluble magnesium, which should make the product especially adaptable for application to soils that respond to magnesium.

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Fermentation of Corn*

Using Fungal Amylases instead of Malt

IN two previous papers[3,6] data were presented on the use of mould amylase preparations in the saccharification of corn mash for alcoholic fermentation. The moulds were cultured on wheat bran in rotating drums. In a general review of the use of microbial amylases in the alcoholic fermentation, one of the authors[5] discussed briefly the relative merits of these materials and malt. The present paper describes a new and more efficient laboratory method for growing the moulds and compares the efficiencies of the mould-bran preparations from twenty-seven strains of moulds, representing four genera, as saccharifying agents in the alcoholic fermentation of corn.

Fermentation Procedure

From the results of preliminary investigations, the following standard procedures were adopted. The stock cultures of the moulds were kept on wort-agar slants. For cultivating the moulds in flasks, transfers were made from well sporulated cultures to wheat-bran mashes. The latter were prepared by mixing equal weights of wheat bran and 0.3 *N* hydrochloric acid in Erlenmeyer flasks and sterilising for 30 minutes at 15 lb./sq. in. steam pressure. The bran mashes were heavily inoculated from well sporulated stock cultures and the flasks, lying on their sides, were incubated at 30°C. For most of the work, 500-ml. Erlenmeyer flasks containing 25 gm. of bran were employed, but it was found later that more rapid growth and sporulation were secured if 10 gm. of bran were used in 250-ml. flasks. After abundant sporulation had taken place, the cultures were used as inoculum for larger batches of bran mash. The well sporulated mould cultures on the bran may be allowed to dry undisturbed in the flasks and kept at incubator or room temperature for many months without loss of potency as inoculum.

The mould amylase preparations were produced by growing the moulds on the wheat-bran mash in special 3-quart aluminium pots equipped for aeration. The apparatus is simply constructed (Fig. 1): it has several advantages over the drum method previously employed in laboratory work[3,6]. It takes less space and requires no special mechanical devices; there is no disturbance of the mould mycelium during growth and more uniform aeration is obtained; the growth of the moulds is more rapid, and the pot preparations lead to more consistent and higher yields of ethanol.

The method of culturing the moulds in the pots is as follows: The bran mash is prepared by moistening 750 gm. of wheat bran with an equal weight of 0.3 *N* hydrochloric acid. The wet bran is packed in the pot and sterilised in the autoclave at 15 lb./sq. in. steam pressure for 30 minutes.

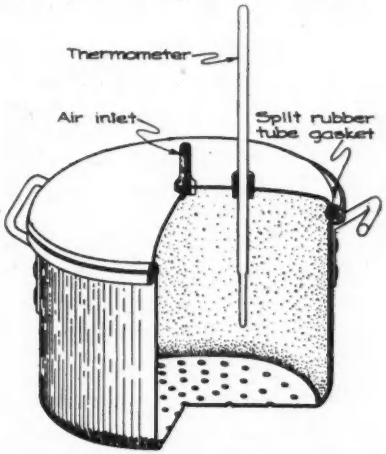

Fig. 1. Apparatus for growing moulds. The three-quart aluminium pot, 7in. diameter and 4½ in. high, is ventilated by a number of ⅛ in. holes

The cooled mash is mixed with 5 to 10 gm. of well-sporulated mould culture grown in flasks on wheat bran mash, and the inoculated material is packed firmly into the pot. The pot is placed on a layer of cotton batting and the material incubated at 30°C. until the temperature rises to 37-40°C. This temperature is reached in about 8 hours and indicates rapid growth of the mould. The mass is then aerated by passing air through the pot at a pressure of 0.3 to 3 in. of water, the flow of air being so regulated as to maintain a temperature below 45°C. After aeration for 12 to 24 hours the contents are removed, spread on paper, and dried at room temperature. The dried material is ground in a Wiley mill and is used as the saccharifying agent in the fermentation tests. Such material is designated "mould-bran."

Yields of ethanol from fermentations of 20 per cent. corn mash, saccharified with the various mould-bran preparations, were employed as the index of their amylolytic effectiveness. The authors believe[6] that the final yields of ethanol furnish the only reli-

* From a paper by Lu Cheng Hao, E. I. Fulmer and L. A. Underkofler.

able means for comparing the usefulness of the saccharifying agents; Lintner numbers are wholly unreliable in such comparisons. The data represent the averages of duplicate fermentations, and all were confirmed by repeated experiments.

The corn meal used in these investigations was prepared by grinding whole yellow corn, obtained in several lots at different times; moisture and starch analyses were carried out on each lot. The starch analyses were made by the official A.O.A.C. diastase method with subsequent acid hydrolysis[1]; the reducing sugars formed were determined by the modified Shaffer-Somogyi method developed in the Iowa laboratories.[7] The average moisture content ranged from 11 to 14 per cent. and the starch content from 56 to 60 per cent. The wheat bran was purchased from a local grain elevator. Blue Ribbon malt extract (Premier-Pabst Corporation) was employed in the preparation of the wort for yeast culture.

Methods of Comparison

The following method was employed in the comparison of the different mould-bran preparations: 60 gm. of corn meal are mixed with 300 ml. of 0.04 *N* hydrochloric acid in a 500-ml. Erlenmeyer flask, and the starch is gelatinised by heating the mash on a hot plate or over a small flame with occasional stirring to produce a uniform paste. The mash is then cooked in the autoclave at 20 lb./sq. in. steam pressure for 30 minutes. On removal from the autoclave the *p*H is adjusted to 4.5-5.0 using sodium hydroxide, sodium carbonate, or calcium carbonate; for most of the work here reported sodium hydroxide was employed. The mash (at 30°C.) is transferred to a mixer, and the mould-bran added in the form of a slurry in water. The mixture is agitated for one minute, returned to the flask, and allowed to stand in the incubator at 30°C. for about an hour. The mash is then inoculated by adding 20 ml. of a 24-hour yeast culture (*Saccharomyces cerevisiae*) grown on a 10 per cent. malt extract medium. After fermentation for three or four days, the fermented medium is transferred to a Kjeldahl flask, and about 0.5 gm. of solid sodium carbonate or a little solid calcium carbonate is added to neutralise the acids. The mixture is then distilled, and exactly 100 ml. of the distillate are collected in a volumetric flask. The specific gravity of the distillate (25°/25°C.) is determined by means of a Chainomatic Westphal balance, and the alcohol content read from an appropriate table.

Corrections were made for the ethanol from the inoculum and from the mould-bran. That is, the activities of the various mould-bran preparations were compared on the basis of the alcohol yields from the starch of the corn alone. The theoretical yield of ethanol was calculated from the well-known equations for the conversion of starch to sugar and the latter to ethanol by alcoholic fermentation.

In a typical experiment the fermentation mash contained 60 gm. of corn with a starch content of 57.9 and a moisture content of 12.5 per cent., 3.6 gm. of mould-bran, and 20 ml. of yeast culture as inoculum. After fermentation for three days the entire fermented mash (365 ml.) was subjected to distillation and the first 100 ml. of distillate was subjected to distillation and the first 100 ml. of distillate collected. The specific gravity (25°/25°) of the distillate was 0.9686, corresponding to 19.77 gm. of ethanol produced from the corn, mould-bran, and inoculum, which represents 5.41 gm. of ethanol per 100 ml. of final beer or 6.87 per cent. by volume. The ethanol derived from inoculum and mould-bran, as determined from control fermentations containing malt extract and mould-bran, was as follows: 0.68 gm. from the 20 ml. of inoculum and $3.6 \times 0.045 = 0.16$ gm. from the mould-bran, or a total of 0.84 gm. of ethanol. Therefore, the quantity of ethanol from the starch of the corn alone was $19.77 - 0.84 = 18.93$ gm. of ethanol. From the equation for the alcoholic fermentation,

$$C_6H_{10}O_5 + H_2O \rightarrow 2CO_2 + 2C_2H_5OH$$

it is evident that the complete fermentation of 162 gm. of starch yields 92 gm. of ethanol; *i.e.*, 1 gm. of starch yields 0.568 gm. of ethanol. In the 60 gm. of corn there were $60 \times 0.579 = 34.74$ gm. of starch which would give a theoretical yield of $34.74 \times 0.568 = 19.72$ gm. of ethanol. The yield from the above fermentation was, therefore, $100 \times (18.93/19.72) = 96.0$ per cent. of the theoretical.

Ethanol Yields

It is evident from the above example that the activities of the various mould-bran preparations were compared on the basis of the alcohol yields from the starch of the corn alone, in terms of the percentage of theoretical yield of alcohol obtained. However, in order to make possible a more ready comparison of the results obtained in this study with industrial plant practice, the data of the above typical experiment may be used to calculate the results as commonly done in the distilling industry. Since 18.93 gm. of ethanol were obtained from 60 gm. of corn, this would represent 18.93 lb. of ethanol from 60 lb. of corn or $56 \times (18.93/60.0) = 17.67$ lb. of ethanol or 5.34 proof gallons of alcohol per bushel of corn as used. Since the corn as used contained 12.5 per cent. moisture, 60.0 lb. would be equivalent to $60 \times 0.875 = 52.5$ lb. of moisture-free corn. The yield on the dry basis, therefore, was $100 \times (18.93/52.5) = 36.06$ lb. of ethanol or 10.9 proof gallons of alcohol per 100 lb. of dry corn, or was $36.06 \times (56/100) = 20.19$ lb.

of ethanol or 6.10 proof gallons of alcohol per 56 lb. of dry corn.

The standard procedures were based upon many preliminary experiments from which it was evident that the alcohol yields are just as good, or better, when the conversion takes place at 30°C. for one hour as at 55° for 1, 2 or 3 hours. In commercial practice it may be advantageous to add the mould-bran at 55°C. to lower the mash viscosity and then pump immediately through the mash coolers into the fermenters. Study of the effect upon alcohol yields of cooking the corn mash with various concentrations of hydrochloric acid for 30 minutes at 20 lb./sq. in. steam pressure showed a definite optimum of 0.04 *N* acid. There was a distinct difference in the consistency of the mash cooked with 0.02 *N* and with 0.04 *N* acid; the former was quite thick, the latter was very thin. The mashes cooked with concentrations of acid higher than 0.04 *N* were brown in colour, and the extent of caramelisation increased with increasing acid concentration. The decrease in viscosity of the mash markedly increases the ease of handling and simplifies the procedure of saccharification. The mash can also be thinned by the preliminary addition of mould-bran or of malt, but the use of acid gave much more uniform results.

Preparations from Different Moulds

Twenty-seven representative strains of moulds were chosen for detailed studies; four genera were included, *Aspergillus*, *Mucor*, *Penicillium*, and *Rhizopus*. Data on the alcohol yields from corn mash saccharified with various mould-bran preparations are given in Table I. All the strains of *Aspergillus* were very active, particularly three cultures of *Aspergillus oryzae*. *Mucor rouxi* and *Mucor circinelloides* proved to be as effective as the Aspergilli; *M. javanicus* was inferior to the other preparations. The two species of *Penicillium* were inferior to the Aspergilli, the *P. chrysogenum* being particularly poor. With the exception of one strain of *R. oryzae*, all the strains of *Rhizopus* gave very active mould-bran preparations.

Effect of Storage

Studies were made of the effect of several variants in the handling of the mould-bran, and it was evident that there was no significant deterioration during storage. In order to avoid deterioration, however, it is advisable that the moisture content be not above 12 per cent.; in a few cases, where the moisture content was from 15 to 17 per cent., spoilage occurred.

It is well known that traces of mineral salts stimulate the growth of moulds. The salts recommended by Steinberg[4] were added to the acid used in preparing the bran mash for the growth of the moulds. To each litre of the dilute acid were added 0.000625 gm. each of ferrous sulphate and zinc sulphate. The addition of the salts increases somewhat the amylolytic activity of the strains of *Aspergillus oryzae* but is disadvantageous with the representatives of *Rhizopus*. It is possible, however, that the latter might be stimulated by different concentrations of the salts.

On the basis of the above data and other repeated experiments, certain strains of *Aspergillus oryzae* proved to be the most

TABLE 1.—ALCOHOL YIELD FROM CORN MASH SACCHARIFIED WITH AMYLASE PREPARATIONS FROM STRAINS OF FOUR GENERA

Mould and Culture No.	Mould-Bran, % of Corn	Alcohol Yield, % of Theory
ASPERGILLUS		
A. niger 1	4	86.4
	6	91.4
	8	91.3
A. niger 3	6	90.0
	8	91.6
A. niger 63	6	84.1
	8	89.5
A. oryzae 2	4	88.6
	6	91.5
	8	93.2
A. oryzae 2	4	90.5
	6	92.8
	8	92.5
A. oryzae 38	4	93.2
	6	93.8
	8	93.5
A. oryzae 40	4	92.5
	6	93.5
	8	93.0
A. oryzae 42	4	89.4
	6	91.1
	8	91.6
MUCOR		
M. rouxii 4	6	87.5
	8	92.7
M. circinelloides 20	6	91.0
	8	92.8
M. javanicus 21	6	72.8
	8	82.8
PENICILLIUM		
P. chrysogenum 7	6	64.7
	8	73.4
P. purpurogenum 8	6	86.1
	8	90.5
RHIZOPUS		
R. delemar 12	6	92.5
	8	93.9
R. delemar 13	6	92.5
	8	93.7
R. delemar 34	4	93.8
	6	93.8
	8	93.4
R. oryzae 14	6	90.5
	8	90.9
R. oryzae 15	6	92.0
	8	93.5
R. oryzae 16	6	85.2
	8	90.5
R. oryzae 17	6	71.6
	8	84.0
R. oryzae 32	4	85.0
	6	90.6
	8	93.0
R. oryzae 33	4	92.8
	6	93.5
	8	94.0
R. nigricans 11	6	81.0
	8	89.5
R. shanghaiensis 35	6	86.9
	8	91.0
R. tritici 19	6	90.8
	8	89.6

satisfactory moulds. Although some of the species of *Rhizopus* gave excellent results, the cultures of *Aspergillus* are much easier to handle. The Aspergilli produce more abundant sporulation, which facilitates growth of the inoculum, makes possible a heavier inoculation of the mash, and thus minimises danger of contamination. Moreover, the mycelium formed by the Aspergilli is more dense and makes the mould-bran easier to handle. The three best strains of *Aspergillus oryzae* all gave yields of about 95 per cent. of the theoretical, and the results are remarkably uniform. It is unlikely that much better alcohol yields than those shown above may be expected under laboratory conditions since some of the carbohydrate must be utilised in building up the protoplasm of the yeast, some alcohol is lost by evaporation, and small amounts of by-products, such as glycerol, are always produced in the normal fermentation.

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LETTER TO THE EDITOR

Talc Control

SIR.—As you kindly published our recent letter concerning the importation and distribution of talc, we think it only fair to request you to allow space in your columns for the following statement. An August 18, a deputation from merchant distributors was received by the Controller, who explained in detail the new scheme which had been devised in the meantime and which gives a place for all those who had a genuine pre-war trade in talc. We should like to add that if anything in our previous letter gave any wrong impression about the Controller, we wish now to withdraw such remarks. We realise he has had a most difficult job to do in bringing order out of chaos, and we are glad he has seen the wisdom of bringing the merchant into the new scheme. We shall do our best to make the new scheme work satisfactorily.—Yours faithfully,

WILFRID SMITH,
Wilfrid Smith, Ltd.
E. A. KITTLE.
Kittle, White & Co., Ltd.

August 31, 1943.

Plastics for Pumps

German Experience

THE need to economise in the use of metals has caused German pump manufacturers to experiment with plastics as a construction material, and it is claimed that the results have not been altogether unsatisfactory. Chemical resistance was generally found to be satisfactory. The main difficulty was caused by the swelling of the phenolics, which is due to the moisture absorption of the fillers. Asbestos was found to be the best material to use in conjunction with plastics. Crushed and milled stone was also found to be relatively satisfactory in this respect, whereas textiles and cellulose products were unsuitable. Thermoplasts without fillers turned out to be much better so far as swelling was concerned, but they were found difficult to press. The valves are mostly made from tubular and flat pieces by welding or glueing. Another difficulty encountered with plastics has been their low maximum temperature, and efforts are being made to improve their resistance to high temperatures. Little experience has as yet been gained in the protection of metal pumps by several coats of resins applied by ordinary painting or annealing. Synthetic rubber has also been used for this purpose because it is resistant to hydrofluoric acid, hydrochloric acid, phosphoric acid, chlorine solutions, sulphurous acid, acetic acid, etc.; its maximum temperature is about 100° C. In machinery construction generally, Vinidur foils (hard polyvinyl chloride) have been used on all metals, with the exception of lead and some light metal alloys, and also in combination with concrete and wood. Oppanol (polyisobutylene) has been used in conjunction with nearly all construction materials. The Vinidur foils are 0.8-1.0 mm. thick, while Oppanol is used in films 2-3 mm. thick, on metal surfaces.

SODIUM AND AERO ENGINES

Sodium is playing an important part in fighters, bombers and transport planes, according to a statement by Du Pont Electrochemicals Department. The metal is being used as a cooling agent in the exhaust valves of aero-engines. The sodium is sealed tightly in the interior cavity of the valve and, as the engine operates, the valve head becomes heated by the combusion of the gases. When the temperature reaches 97.5°C. this leads to the melting of the sodium, and the motion of the valve then proceeds to spray the liquid sodium over the entire inner surface of the head cavity. The sodium absorbs the heat from the head and is thrown into the stem of the valve, when the absorbed heat is dissipated through the stem guide to the cylinder and the cooling system.

War-Time Demand for Nitrogen Compounds

U.S. Bureau of Mines Report

NITROGEN, in one compound or another, is an essential element in the domestic economy of the United States. How America at war is meeting the nitrogen demands of her industry and agriculture is described in a recent survey of the Bureau of Mines. About 500,000 short tons were consumed there yearly in normal pre-war times—nearly 400,000 tons in agriculture, and the balance in industry. According to the Bureau of Mines, United States Department of the Interior, the current war greatly increased the domestic need for nitrogen for both agricultural and industrial purposes, far beyond productive capacity or importation possibilities available at its start; the result was a shortage. In the recent past the demand for this element was met largely from domestic sources; at the outbreak of the present war about 70 per cent. of the domestic consumption of nitrogen was coming from domestic plants, although the estimated capacity for production was reported to be slightly greater than the peacetime demand.

Reduced Imports

The domestic demand for nitrogen was ordinarily met by the fixation of atmospheric nitrogen, the recovery of nitrogen as a by-product of coal distillation and the importation of nitrogenous compounds, chiefly nitrates from Chile, cyanamide from Canada, and ammonium sulphate from Europe and Japan, supplemented by various organic nitrogenous compounds of domestic and foreign origin used exclusively in fertilisers. The war cut off some imports, hindered the importation of other commodities, and totally upset the domestic nitrogen economy. Munitions factories had first call on the lessened nitrogen supply and the military demands for nitrogen were so great that there was not enough for agricultural needs. Restrictions were placed on the use of nitrogen in fertilisers and one after another nitrogen compounds were placed under allocation. Consumption in 1942 was exceedingly heavy and the supply was not equal to the demand either for munitions or agricultural use. Agriculture attempted to turn to organic nitrogenous materials for fertiliser use, and new synthetic nitrogen plants were started to satisfy the demand for explosives.

Deposits of soluble nitrate minerals are widely distributed in small quantities in the United States. Indeed, the geological and topographic conditions under which nitrate deposits might occur are so widespread that almost any part of the country might be expected to yield minor quantities. Already nitrate deposits have been found in 23 States, including the humid States of Pennsylvania, Tennessee and Alabama, but occurrences are much more numerous in the arid and semi-arid parts of the West. Three types of nitrate deposits are known—cave, caliche, and playa. The cave nitrates are the more widely distributed, the caliche and playa types occurring only in the arid regions. The cave deposits contain the wider variety of nitrate salts, including potassium, sodium, calcium and more rarely magnesium and ammonium nitrate. The caliche and playa deposits are chiefly of sodium nitrate. But natural nitrate deposits known to occur in the United States are too small and too low grade to serve as a basis for a domestic nitrate industry. Furthermore, the general conditions under which nitrates occur in nature are quite well known, and this knowledge affords little hope that deposits of commercial size or quality will ever be found.

So far as is known the United States has no domestic production of natural nitrates at present. Cave nitrates were used occasionally in the past, especially during the Civil War, as a source of the saltpetre essential in the manufacture of gunpowder. The domestic caliche and playa nitrate deposits have never been worked.

Natural sodium nitrate, and smaller quantities of potassium-sodium nitrate are imported from Chile. All Chilean nitrate of soda imported from July 1, 1942, to the end of the year was for the account of the Defence Supplies Corporation, a subsidiary of the Reconstruction Finance Corporation. Imported, as well as synthetically-produced domestic sodium nitrate, is under allocation, approximately 80 per cent. for agricultural, and the remaining 20 per cent. for industrial uses. Control of allocation is under General Preference Order M 62 of January 15, 1942, effective February 1, 1942. A stockpile of Chilean nitrate was started in Chile in 1941 by the United States Government.

Synthetic Ammonia

Primary nitrogen is produced in the United States chiefly as ammonia gas, made principally by the high-temperature reaction of pure nitrogen and hydrogen under pressure in the presence of a catalyst. A relatively smaller quantity is recovered as a by-product of the coking of coal. Ammonia is now used principally in military explosives, and, to a slightly less extent, in the manufacture of nitrogenous fertilisers. Smaller quantities

are used in industrial explosives, chemicals, and in various minor ways. Agricultural consumption in 1942 is believed to have been less than in 1941 because during part of the year the use of these commodities for the direct ammoniation of superphosphate was prohibited, and the supplies were diverted to direct war uses.

Synthetic Ammonia

Ammonia was one of the first chemicals to become scarce because of military demands. Although the production of snythetic ammonia at privately-owned and Government plants is reported to have made an all-time record in 1942, the supply was still short because of the greatly increased demand for use in making munitions and in other war industries. The United States capacity for the production of synthetic ammonia is being vastly increased. Several new plants have been erected and others are in process of erection. It is reported that eventually there will be synthetic ammonia plants in ten or more States.

Last year both by-product ammonia and synthetic ammonia were placed under complete allocation by the War Production Board, but there was no Government stockpiling in 1942.

Ammonium sulphate, obtained as a by-product in the coking of coal, is one of the most important agricultural fertilisers and one of the principal sources of nitrogen in mixed fertilisers. Production of sulphate of ammonia increased in 1942 over 1941, but sales declined from 756,569 short tons in 1941 to 751,914 tons in 1942, because of restrictions on the use of the material and allocation of smaller amounts than customarily used. As a result of the urgent demand for this material, supplies were reported as definitely short early in 1943. By-product ammonium sulphate was placed under allocation by the War Production Board in May, 1942. Allocation did not change the pattern of use and most of the ammonium sulphate is stated by the War Production Board to have gone to the fertiliser industry, but smaller quantities were allocated than before.

Ammonium Nitrate

Ammonium nitrate, hitherto used chiefly in the manufacture of explosives, is being utilised to a considerable extent on the Pacific, Gulf, and South Atlantic coasts of the United States as a nitrogenous fertiliser. The T.V.A. nitrate plant at Muscle Shoals, Alabama, was modernised and rehabilitated in 1942, and began the production and shipment of ammonia nitrate for explosives and then for fertilisers. Imports of a nitrogen-bearing fertiliser consisting of a mixture of ammonium nitrate and limestone, and containing 34 per cent. of nitrogen, produced in the Province of Ontario, Canada, were released by the War Production Board early in 1943 for direct application to the soil in Gulf and Atlantic Coast States.

When the United States entered the present war, only one domestic plant was producing synthetic sodium nitrate—the Hopewell, Virginia, plant of the Allied Chemical and Dye Corporation, which had been producing this commodity since 1928, and marketing it as "Arcadian sodium nitrate." Several new domestic plants have been erected and began operation in 1942. Most of the domestic synthetic nitrate of soda produced in 1942 is reported to have gone to munitions plants, and the remainder to fertiliser consumers, as contrasted with imports of Chilean natural nitrate, most of which was used as fertiliser. The allocation of synthetic nitrate of soda is covered by the same order as is Chilean nitrate.

Cyanamide

Imported Canadian calcium cyanamide, a synthetic fertiliser, containing 20 to 22 per cent. of nitrogen, has contributed materially to United States needs. It has been produced since about 1910 at the plant of the American Cyanamid Co., of New York, at Niagara Falls, Canada. This plant in 1937 had a capacity of 78,100 tons of fixed nitrogen a year. This product is not now manufactured in the United States. Domestic production has been limited to a single venture of the United States Government. Domestic consumption of cyanamide in the United States was about 21,000 tons in 1939 and 26,000 tons in 1941. Calcium cyanamide is, like other chemical nitrogen fertilisers, under allocation.

Organic Nitrogen Compounds

Organic nitrogenous materials, of vegetable or animal origin, such as tankage, fish scrap, cottonseed meal, castor pomace, dried blood, guano, bones, sewage sludge, and tobacco stems, are utilised entirely in the fertiliser and feed industries, and are therefore competitive with chemical nitrogen products. The best grades, however, contain an average of only 5 to 12 per cent. nitrogen, whereas chemical nitrogen products contain up to 46 per cent. The demand for some of these materials for animal feed is increasing. Restriction in the use of chemical nitrogen in fertilisers after September, 1942, resulted in an increased demand for organic nitrogen compounds, and competitive bidding by feed makers and fertiliser interests led to shortages of unequal distribution. Certain restrictive orders were established early in 1943.

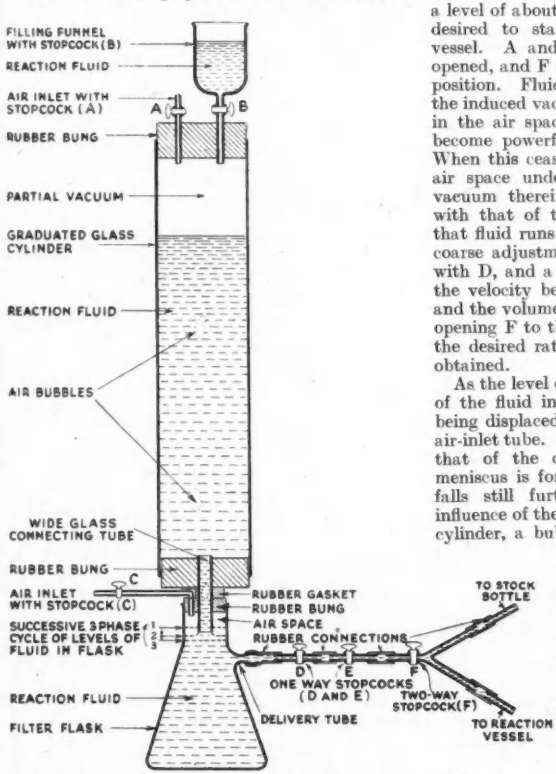
Allied bombers attacked Iglésias, the mining centre in Sardinia, last week. Five direct hits were scored on a zinc factory. The town's zinc works and magnesium plant were heavily hit in a previous raid.

Constant-Velocity Drip Feed

A Simple Device for Maintaining Regularity

by H. BOYNTON RAYNER

WHEN in the course of normal laboratory operations a separating funnel is employed for a drip feed, the drip velocity decreases with the amount of residual fluid in the funnel. In cases where a constant-velocity drip feed of the order of 60 drops per minute is desired, the necessity for the operator to maintain the fluid level in the funnel almost continuously may conveniently be obviated by the use of the apparatus—consisting mainly of a one-litre measuring cylinder with the base removed, and a 300-c.c. filter-flask—shown in the self-explanatory diagram.



In operating this apparatus, C, D, E and F are closed, and A and B opened. The reaction fluid is introduced through the filling funnel to a level of about ½ in. above that at which it is desired to start the flow into the reaction vessel. A and B are then closed, D and E opened, and F turned to the "to stock bottle" position. Fluid runs into the stock bottle until the induced vacua in the top of the cylinder and in the air space at the top of the filter flask become powerful enough to prevent the flow. When this ceases, C is opened. Air enters the air space under the influence of the partial vacuum therein, thus equalising the pressure with that of the atmosphere, with the result that fluid runs freely into the stock bottle. A coarse adjustment of the rate of flow is made with D, and a fine adjustment with E. When the velocity becomes that desired, F is closed, and the volume in the cylinder noted. On fully opening F to the "to reaction vessel" position the desired rate of flow is almost immediately obtained.

As the level of the delivery tube is below that of the fluid in the filter flask, fluid runs out, being displaced by the air entering through the air-inlet tube. When the level falls to just below that of the connecting tube (position 2) a meniscus is formed, which breaks as the level falls still further (position 3). Under the influence of the partial vacuum at the top of the cylinder, a bubble of air is sucked in through the connecting tube to the top of the fluid in the filter flask, fluid runs out, being displaced by the air entering through the air-inlet tube. When the level falls to just below that of the connecting tube (position 2) a meniscus is formed, which breaks as the level falls still further (position 3). Under the influence of the partial vacuum at the top of the cylinder, a bubble of air is sucked in through the connecting tube to the top of the fluid in the cylinder, thus displacing a small amount of fluid from the connecting tube into the flask. The level therefore rises to position 1, and the cycle is repeated. As the effective pressure-head is the pressure due to the difference in level between the delivery and the fluid in the flask, and as the latter level varies by little more than a millimetre, the pressure, and hence the drip velocity, is practically constant, and independent of the level of fluid in the cylinder.

In Sweden there are 73,650 producer-gas vehicles corresponding to 91.5 per cent. of all operating automobiles. In addition, about 15,000 tractors and a considerable number of fishing boats and auxiliary vehicles run on charcoal or wood.

A new building to house the research and technological divisions of the National Chemical Laboratory of Colombia is being built at a cost of $300,000. Space is being provided for the installation of pilot plants of various types.

Personal Notes

DR. JOHN J. GREBE, director of the Physical Research Laboratory of the Dow Chemical Company, has been awarded the Chemical Industry Medal for 1943 of the American Chemical Society. Dr. Grebe invented the process used by his company for the extraction of bromine from sea-water, and contributed to the perfection of the technique of recovering magnesium from sea-water.

The annual general meeting of the Midland section of the Insitution of the Rubber Industry elected the following members to its 1943-44 committee :—MESSRS. J. ANDERSON, H. E. DAVIS, J. W. DENSON, J. GRASON, F. A. JONES, R. N. MANNING, L. R. MERNAGH, E. A. MURPHY, D. PARKINSON, E. F. POWELL, G. A. SHIRES, F. THOMAS, E. S. TOMPKINS, G. W. USHERWOOD, J. I. S. WILLIAMS.

The celebration of his golden wedding has brought many congratulations from old friends to MR. GEORGE SHAW, now living at Wishaw. A native of Co. Down, he came to Scotland to work for the Dalmellington Iron Company, serving them for over 40 years. After twelve years as manager of the ammonia works of that firm, he went to Glasgow as manager of a similar ammonia and chemical production plant until the firm closed down in 1930, when he retired. Mr. Shaw is still in good health at the age of 73.

MR. GORDON ROBBINS, chairman of Benn Brothers, Limited, proprietors of THE CHEMICAL AGE, delivered his second successive presidential address to the Institute of Journalists, at their annual meeting in London on September 4. Mr. Robbins was outspoken in his insistence on the need for the complete independence of the Press as soon as the controls necessary in war time were loosened. The keynote of his recommendation to the journalist of the future was reliance on self-control, not on State control, coupled with a tightening-up of the professional standards which the Institute strives to uphold.

Obituary

The death is reported of CAPTAIN W. E. EVANS, A.R.C.S., B.Sc., F.I.C., who was killed on August 24 in a climbing accident in Syria. He had recently transferred to the Middle East Force Mountain Warfare Training School as a rock-climbing instructor, after having been a staff captain for over a year in Cairo. Captain Evans, who was educated at Blundell's school and the Royal College of Science, had been a partner in the firm of Mactaggart & Evans, industrial consultants, for the past seven years.

The death occurred on August 30 at Sandy, Bedfordshire, of MR. JULIUS LEONARD FOX VOGEL, M.I.E.E., M.Inst.M. & M., M.I.Chem.E., at the age of 70. From 1894 to 1907 he was associated with Dr. O. J. Steinhart in the firm of Steinhart and Vogel, consulting chemical engineers. Being interested in the manufacture of tungsten, he was commissioned in 1914 to design and erect a factory at Widnes for the production of that and other metals needed for alloy steel, and he remained as general manager of the firm (High Speed Steel Alloys, Ltd.) until his death.

SCIENTIFIC WORKERS AND THE T.U.C.

At the Southport conference of the T.U.C. this week a resolution was passed unanimously, calling upon the General Council to consider the possibility of legislation for setting up trade-union machinery in any commercial undertaking in which a substantial proportion of manual, non-manual, technical, or scientific workers are members of *bona fide* trade unions. The A.Sc.W. national organiser, Mr. Ben Smith, speaking on the resolution, said that some employers were resisting the organisation of technical and scientific workers with the same stubbornness that they had shown towards the manual workers a hundred years ago. He considered that co-operation between manual and non-manual workers was vital. Mr. Smith also moved a resolution demanding immediate facilities for study and technical training during employers' time without loss of earnings. Mr. George Chester, on behalf of the General Council, expressed admiration of the aim behind the resolution, but pointed out that there were practical difficulties. The proposal was then referred to the General Council. The A.Sc.W.'s other representative, Mr. R. S. Bickle, urging the necessity of technicians on production committees, spoke of new weapons coming into production that would mean great changes; whole factories would have to change their methods and large numbers of workers be transferred.

CARDIFF'S COAL EXHIBITION

A committee of experts has been formed at Cardiff to organise and stage a comprehensive exhibition on coal utilisation. The exhibition is being planned to assist in putting Welsh coal and by-products on world markets, and the committee will be supported by the Monmouthshire and South Wales Coalowners' Association and the South Wales Miners' Federation. No date has yet been fixed for the exhibition, "which will be the largest and most comprehensive of its kind ever held in Britain," but it will be held as soon as practicable.

Plastic and Glass Piping

Meeting the Metal Shortage

SHORTAGE of metals for making pipes has led to the development of some interesting substitutes. *Chemical and Engineering News* of July 10 reports, for instance, the use in the magnesium plants of the Dow Chemical Co. of pipes produced from the thermoplastic material "Saran," devised by Dow chemists. This piping, it is clamed, possesses a range of distinctive properties such as toughness, durability, long life, and a high degree of resistance to chemicals and to scale, which are valuable in the electrical, oil, gas, and chemical industries. Piping of this material can be quickly set up because of its semi-flexibility and the wide range of fittings which are made by injection-moulding of "Saran." It can be cut to size quickly and welded on the job within one minute by employing a nickel- or chromium-coated plate which is heated to 200-260°C. The pipe ends are placed against this hot surface until a molten bead of material is visible on the outside of the ends; the two ends are then pressed firmly together and allowed to cool, producing a joint with a strength equal to that of the original pipe.

In this country more and more industrial glass piping is coming into use. This material is not to be described as a war-time substitute, however, since where a high degree of purity is needed in a product glass is superior to all other materials for pipe-lines. At least two British firms are making heavy glass piping for use in industry: these are J. W. Towers & Co., Ltd., of Widnes, and James A. Jobling & Co., Ltd., of Sunderland. Towers' "Dreadnought" glass pipe-lines are made of borosilicate glass that is non-brittle, mechanically strong, of high chemical resistance, and capable of withstanding sudden temperature changes. It is supplied in sizes up to 2 in. bore, in straight lengths, right angle or U-bends, T or Y pieces, etc. The earlier objection to the use of glass pipe-lines, namely the difficulty of making a satisfactory connection between the lengths of glass tubing, has been overcome by connectors of special Nordac ebonite; these connectors form a full-bore joint which, while being mechanically strong, has sufficient flexibility to take up local stresses. The connectors, too, are corrosion-resistant, hence the whole pipe-line system is unaffected by exposure to conditions which would rapidly corrode metal. James A. Jobling & Co., Ltd., market Pyrex-brand glass pipe-lines, with suitable connections, for industrial use. In America a similar product is said to be capable of withstanding working pressures of 400 lb./sq. in. in lengths up to one foot, while it will take 140 lb. pressure when in 6 ft. lengths.

It is interesting to note that in China, where brilliant improvisation is needed to meet the very serious shortages in all her war industries, bamboo has been pressed into use as piping. Dr. Joseph Needham, who is on a scientific mission to China for the British Council, reports that miles of this bamboo tubing are used to pipe natural gas from "self-flowing wells" in Szechuan province; miles of it curve about the countryside, bound with bamboo tape, the lengths cemented together by fibre, lime, and tung oil, making joints that are capable of withstanding pressures up to 80 lb./sq. in.

General News—From Week to Week

The Chemical Workers' Union became reaffiliated to the Trades Union Congress at the Southport conference this week.

Earplugs are being made from scrap plastic material left over from the production of Plexiglas bomber noses and gun turrets.

Under a new order of the Ministry of Supply waste tinplate may be used for the closures for packaging certain medicinal, pharmaceutical and food products.

The Trading with the Enemy (Specified Persons) (Amendment) (No. 12) Order, 1943 (S.R. & O. 1943, No. 1249), contains the names of 320 additional persons and firms with whom it is unlawful to have dealings of any kind, including Soc. de Minerales y Productos Derivados, S.A., of Madrid. Deletions from the list amount to 70.

The guaranteed week, as introduced for dockers in war-time, might safely be introduced as a guaranteed month or even a guaranteed quarter for a large proportion of British industries, said Mr. J. Hansard, a director of Lever Bros. and Unilever, Ltd., at the Institute of Labour Management Conference last week-end.

The International Society of Leather Trades' Chemists members are asked to address all communications to Mr. G. H. W. Humphreys, c/o Messrs. J. J. Williamson & Sons (Canterbury), Ltd., St. Mildred's Tannery, Canterbury, Kent, who has agreed to act as hon. secretary on the resignation of Mr. A. Harvey. The latter has become acting hon. general secretary of the Society during the indisposition of Dr. J. Gordon Parker.

The Board of Trade has, with the approval of the Treasury, decided that, in respect of the six months beginning October, 1943, and ending March 31, 1944, the rate of premium payable under any policy issued under the Business Scheme shall be at the rate of 5s. per cent.

Paper-based plastic is being used for making battery boxes for the Army's pack radios. The boxes have the double advantage of being very light and resistant to battery acid. The same material provides containers for anti-malaria equipment, first-aid boxes, Oxford vaporisers and surveying instruments. The land-mine detector is also mainly made from it.

A new regulation eliminates a major difficulty in the running of producer-gas vehicles. For many years drivers of motor vehicles have been prohibited from leaving their vehicles unattended with the engines running. Under the new ruling drivers are able to leave a producer-gas vehicle for a short time without switching off the engine, so maintaining the gas supply.

Diabetic sufferers in this country are estimated to number 200,000, and of these 130,000 depend on daily doses of insulin. The task of ensuring adequate supplies of insulin has been made easier by the remarkable collaboration between manufacturers, which originated in the "blitz" days and now extends to all phases of insulin production, including research.

A new schedule of war risk rates, showing reductions in most sections, has been announced by the Government War Risks Insurance Office, to take effect from September 1. The rate chargeable for unlimited transhipment will be 20s. per cent., whether or not the ocean voyage concerned is insured against war risks with the War Risks Insurance Office.

A district committee of the National Joint Industrial Council for the paint, colour and varnish industry was recently formed at Newcastle, to give advice to the Ministry of Labour regional office on man-power problems affecting the trade. There are two representatives for the workers, and the employers are represented by Mr. J. W. Adamson (British Paints, Ltd.), Mr. Dick (Wailes Dove), and Mr. S. E. Groves (International Paint and Compositions Co., Ltd.).

Civil Service scientists, through their organisation, the Institution of Professional Civil Servants, have sent a donation of £100 towards the Stalingrad Hospital Laboratory Fund. The organisers of the fund at the Association of Scientific Workers' headquarters have already received over £600 in direct donations. When collection sheets have been returned, it is expected that the total will be well on the way to the target of £3500.

A tribute to the success of joint production committees was paid last week-end by Mr. C. U. Peak, joint Parliamentary Secretary to the Ministry of Supply. He said that the resilience and elasticity of our production was something to be proud of.

Employers of quarry workers who provide washing facilities will be able to obtain supplies of soap, under an arrangement made by the Ministry of Food. The allowance made is one ration per four-weekly period in respect of each worker for whom the washing facilities are provided. Applications for the allowance should be made to the Food Office.

Foreign News

British Columbia is producing linseed oil, for the first time, from flaxseed brought in from the neighbouring province of Alberta.

A scientific congress is being held this month at Santiago, Chile. Scientists from all the American republics have been invited.

The first Canadian plant for preparing activated silica gel has been completed by G. F. Sterne and Sons, Ltd.

A petroleum institute, on the lines of the one in the United States, has been established in Bogotá, Colombia.

Tanning materials from mangrove wood are to be produced at a new plant near Buenaventura, Colombia.

Advertising of synthetic rubber products and of vulcanised synthetic rubber articles has been prohibited in Canada.

A geological formation containing millions of tons of vanadium ores has been located at Sublette Ridge, Idaho, and exploitation of the deposit is now proceeding.

A synthetic rubber sponge that stays soft and compressible at −40°F. has been developed by chemists of the B.F. Goodrich Company, U.S.A.

An eight-year old ban on the development of new sources of potash has been lifted in America, in order to help meet the increased demands for agricultural and manufacturing purposes.

Many paint specifications in America call for certain qualities of infra-red reflectivity, indicating a widespread use of camouflage paints that defy detection by the infra-red camera.

North African phosphate supplies are estimated at 4,000,000 tons, of which 500,000 tons are to go to Spain and Portugal, 30,000 tons to Switzerland and the balance to Britain.

Shawinigan Chemicals, Ltd., are awarding nine new scholarships, worth $500 each, for postgraduate research in chemistry and chemical engineering at Laval University, Quebec.

Oil is being extracted from the Athabasca oil sands of Alberta, Canada, first discovered in 1788. The Federal government has made a grant of $500,000 so that these deposits can be fully exploited.

Twine made from paper is being used in Sweden's mechanical binders that are bringing in this year's harvest. Production of twine from domestic raw materials is made possible by this substitute for hemp.

An Anglo-Portuguese trading company, Collaboration Unlimited, has been registered to engage, "whether for profit or not, in any business or activity with or in connection with Portugal or Portuguese territory (excluding banking and insurance)," according to Jordan's Daily Register.

A Canadian section of the Society of Plastics Industry has been formed. Its chairman is Mr. A. E. Byrne, manager of the plastics section of Canadian General Electric Co. and secretary of the Plastics Advisory Committee to the Department of Munitions and Supply, Ottawa.

American research into quinine will be intensified as a result of special grants to the universities of Cornell, New York and John Hopkins made by the Cinchona Products Institute. Two research fellowships for accredited workers in cinchona alkaloids have also been announced by the Institute.

Recent estimates presented to the U.S. Government reveal that the Office of Scientific Research and Development, headed by Dr. Vannevar Bush who recently visited Britain, has 1100 research contracts with over 200 industrial organisations and 124 academic institutions.

Supplies of helium from factories in the United States are now a quarter above pre-war output, Mr. Harold Ickes, Secretary of the Interior, announced. New plants for the manufacture of this light-weight, non-inflammable gas include one being built in New Mexico on a reservation of the Navajo Indians.

Over half the Donetz Basin has now been recaptured by the Russian Army. Some of the richest coalfields are in that region, and its industrial installations include many metallurgical factories and enterprises for the exploitation of coal by-products. Before the German occupation several plants for the underground gasification of coal had been established there.

A chemical company in Rochester, New York, was recently charged with causing a public nuisance, neighbouring householders complaining in court that fumes escaping from the plant were injurious to health and property. The judge dismissed the case, holding that war production held precedence over the "comfort and repose" of the community.

The East Rand Consolidated group, which owns considerable blocks of claims on the Far Eastern Rand, is to test its areas for the Kimberley Reef series by means of boreholes. At the annual meeting last week, Capt. H. B. Jameson, the chairman, said that it was proposed to start a programme of drilling at the earliest possible moment after the tests.

American medium bombers last week attacked in daylight a chemical works at Mazingarbe, near Bethune. Many hits were observed on the chemical plant, one of the largest industrial works in Northern France. The plant had four batteries of coke ovens and manufactured synthetic ammonia, synthetic alcohol, fertiliser, benzol, ether, synthetic petrol and nitric acid.

U.S. Bureau of Mines field crews have completed a three-year exploration of the Stillwater chromite area of S.E. Montana. The project has helped in the extensive commercial exploitation of deposits estimated to contain 2,500,000 tons of chromite, and in its first year of development this region turned out more than three times as much chromite as was produced in the United States during the 20 years before the war.

A possible substitute or supplement for blood plasma, consisting of a solution of hydrolysed proteins, is suggested by two research workers of the Washington University Medical School. In tests with laboratory animals, solutions made from pure crystals of all the essential amino acids were found beneficial in blood transfusions, but solutions of hydrolysed proteins were more effective.

Forthcoming Events

The London section of the **Institution of the Rubber Industry** is holding a "Brains Trust" session at Caxton Hall, Caxton Street, S.W.1, on **September 13** at 6.30 p.m., when questions will be answered by Mr. T. R. Dawson, M.Sc., F.I.C., Dr. Philip Schidrowitz and Dr. H. J. Stern.

The British Rheologists' Club is holding a discussion on "Rheology in the Hosiery, Leather, Shoe and Allied Trades" at Loughborough College on **September 18.** The meeting starts at 10 a.m., and visits to laboratories in the neighbourhood are arranged for the afternoon.

The next meeting of the **Manchester group** of the British Section of the **International Society of Leather Trades' Chemists** will be held at the Engineers' Club, 17a Albert Square, Manchester, on **September 18.** The agenda will be as follows: "The Effect of the Structure of the Hide on Vegetable Tanning" by W. R. Atkin, M.Sc., and "Laboratory Tests Applicable in a

Chrome Upper Leather Factory" by S. Wolstenholme.

The 1943 conference of the **Association of Special Libraries and Information Bureaux** to be held in the rooms of the Royal Society, Burlington House, London, W.1, on **September 18-19**, will discuss some of the outstanding problems of the rehabilitation of special library and information services after the war, with a view to giving a lead to immediate action. At the inaugural session, Professor J. D. Bernal, F.R.S., will draw a picture of what must be expected of information services if they are to fulfil their positive function in the scientific life of the post-war world.

The London Section of the **Society of Chemical Industry** has arranged a joint meeting with the **Road and Building Materials Group** and the **Institution of Structural Engineers**, to be held on **September 23**, at No. 1 Grosvenor Place, London, S.W.1, at 5 p.m. Dr. E. F. Armstrong, F.R.S., will read a paper on "Post-War Building: The Chemist's Contribution."

The **Faraday Society** is holding a whole-day conference on "Modes of Drug Action" at the Hotel Rembrandt, South Kensington, on **September 24.** Sir Henry Dale, president of the Royal Society, will open the conference, and the symposium will include papers by Professor J. H. Gaddum, Professor E. K. Rideal, and Professor C. N. Hinshelwood.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

BI-METAL PRODUCTS, LTD., London, S.W. (M., 11/9/43.) Aug. 21, £20 debs., part of a series already registered.

Satisfaction

NICHOLSONS (NEWCASTLE-ON-TYNE), LTD., chemical manufacturers. (M.S., 11/9/43.) Satisfactions August 19, of debentures registered October 18, 1920, and February 15, 1922.

Company Winding-up Voluntarily

ASHE LABORATORIES, LTD. (C.W.U.V., 11/9/43.) Members' voluntary liquidation, August 19, the directors having filed a declaration of solvency. S. R. Stammers, Abford House, Wilton Road, S.W.1, appointed liquidator. The liquidator is authorised to enter into an agreement for sale of all the assets and undertaking of the company for fully paid shares in a new company to be formed having a name identical with that of this company.

Company News

International Bitumen Emulsions, Ltd., are again paying a 6 per cent. dividend, for the year ended March 31. Revenue for the year was £22,707 (£35,229).

The United Indigo and Chemical Co., Ltd., announce a profit, for the year to June 30, of £9654 (£9305), and an ordinary dividend of 6¼ per cent. (same).

Bradford Dyers' Association announce the payment of a dividend on the 5 per cent. cumulative preference for the half-year ended June 30, payable September 30.

New Companies Registered

Tudor Sundries, Ltd. (382,325.) Private company. Capital £100 in 100 shares of £1 each. Manufacturers of and dealers in chemicals, drugs, preservatives, disinfectants, fertilisers, paints, oils, toilet requisites, builders' materials, etc. Directors: Izaak Frydman, 57 Tudor Close, N.W.3; Geoffrey T. Lloyd.

Styx Products, Ltd. (382,379.) Private company. Capital £100 in 100 shares of £1 each. Manufacturers of and wholesale and retail dealers in glues, adhesives, gums, size, chemicals, fertilisers, plastics, synthetic products, etc. Subscribers: P. Lewis, E. Sartain. Solicitors: Manches and Co., 4 Broad Street Place, E.C.2.

Chemical and Allied Stocks and Shares

ENCOURAGED by the war news, sentiment in the stock and share markets has been good, but there has been only moderate improvement in the volume of business, and the majority of movements in values were small on balance. Imperial Chemical were maintained at 38s. 9d. awaiting the interim dividend announcement, while Lever & Unilever at 37s. 6d. were little changed pending publication of the financial results. Borax Consolidated deferred held their recent improvement to 37s. 9d. Elsewhere, Murex remained firm at 101s. 3d. on the assumption that the forthcoming results are likely to show a dividend at the same rate as for the previous year. At 18s. 4½d. General Refractories fully held their recent rise, and British Oxygen were higher at 77s. 9d.

B. Laporte showed a larger number of

dealings, which have ranged up to 79s. 3d. at the time of writing. There was again a fair amount of attention given to shares of companies connected with plastics. British Industrial Plastics 2s. ordinary were 7s. 1½d., and Thomas De La Rue were higher on balance at 156s. 3d., while, pending the dividend statement, Erinoid 5s. ordinary remained at 12s. 6d. Activity in rayon shares was quite well maintained: British Celanese at 33s. 9d. were at the same level as a week ago. Courtaulds were 55s. compared with 55s. 3d. Awaiting results for the past financial year, Triplex Glass 10s. ordinary have further risen from 38s. 6d. to 40s. although, as in most other directions where gains have been shown, this was attributed mainly to buying on long-term hopes of recovery in dividend payments after the war.

More attention has been given to the units of the Distillers Co. which have risen from 87s. 6d. to 89s. 6d., partly because of future prospects for the company's diversified interests, which include plastics. United Molasses 6s. 8d. units also showed a better tendency, and were 32s. 7½d., compared with 32s. a week ago. British Plaster Board 5s. ordinary moved slightly higher to 29s. Elsewhere, Associated Cement remained around 64s., the disposition being to await the interim dividend announcement. Turner & Newall were 79s. 3d. Wall Paper Manufacturers deferred were well maintained at 42s. 6d. Various iron and steel shares were better; in some instances buyers were attracted by the apparently favourable yields. Guest Keen have risen on balance from 34s. 3d. to 35s., Tube Investments to 92s. 9d., Stewarts & Lloyds to 52s. 9d., and United Steel from 24s. 6d. to 25s. Staveley were 52s. 9d., Richard Thomas ordinary 10s. 6d., and Consett Iron 6s. 8d. units 8s. 1½d.

Fisons were 52s. 6d., Burt Boulton 19s. 6d., and Lawes Chemical 10s. shares changed hands at 11s. 6d. Awaiting the financial results, Leeds Fireclay ordinary transferred around 7s. Elsewhere, Goodlass Wall 10s. ordinary, at 16s., continued to hold the greater part of their recent improvement. Greeff-Chemicals 5s. ordinary changed hands at 7s. 6d., and British Drug Houses at 23s. W. J. Bush continued to be quoted at 53s. 9d. Dealings up to 8s. 9d. were shown in William Blythe 3s. ordinary. Monsanto Chemicals 5½ per cent. preference kept at 23s. 6d.

In other directions, Boots Drug 5s. ordinary were 43s. 6d., while Timothy Whites were 31s. 1½d., and Sangers improved from 23s. 1½d. to 23s. 7½d. Beechams Pills deferred were 17s. 3d., awaiting the interim dividend announcement. Barry & Staines eased from 44s. 6d. to 44s Nairn & Greenwich were again 68s. 1½d. Oil shares, following an earlier rise, showed a reaction, but the tendency has become steadier at the time of writing.

British Chemical Prices

Market Reports

A MODERATE volume of new inquiry has been dealt with during the past week on the London chemical market, while the movement of supplies is principally against existing contracts which are being satisfactorily drawn against. Strong price conditions are reported from most sections of the market and there is a slight tendency towards higher levels. In the soda products section a steady inquiry is in evidence for both grades of hyposulphite of soda and a good demand is reported for acetate of soda, Glauber salt, and salt cake. There is no improvement in the supply position of yellow prussiate of soda, and supplies of industrial refined nitrate of soda are moving steadily into consumption. Percarbonate of soda is a good market. The potash chemicals generally are strong in price and short in supply. Priority users of caustic potash and bichromate of potash are pressing for supplies and there is a ready outlet for offers of yellow prussiate of potash. In acid phosphate of potash business has been on steady lines. Among the miscellaneous chemicals, home producers of formaldehyde report a steady demand, while makers of peroxide of hydrogen have good order books. There has been little change in the position of alum lump, which is moving into consumption in substantial quantities. Pure glycerine, as well as the crude material, is in brisk demand on the basis of the fixed rates. Sulphur of all available grades is being steadily absorbed at firm prices and a moderate volume of inquiry is reported for acetone. In the coal-tar products market crude tar is in steady demand and all qualities of creosote oil are in good request, while a moderate volume of new business has been arranged in the anthracene oils. Xylol continues a good market.

MANCHESTER.—Traders on the Manchester chemical market during the past week have reported a fairly steady movement into consumption against contracts so far as the leading classes are concerned and, on the whole, a fair amount of replacement business is coming through, though most of the leading industrial consumers are reasonably well covered. Most descriptions of soda compounds are meeting with a steady inquiry and there is a ready absorption of the general run of potash chemicals, which remain in short supply. Both carbonate and bicarbonate of ammonia are in fair request, and there is a steady demand for the magnesia products. Interest in sulphuric and other acids has been well maintained.

GLASGOW.—There is no actual change in the position in the Scottish heavy chemical trade during the past week. Home business remains steady. Export inquiries are very limited. Prices remain firm.

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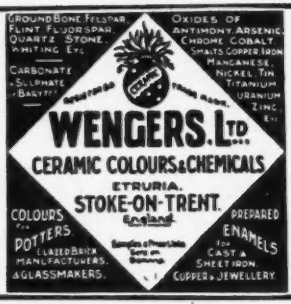
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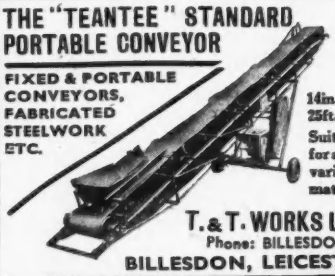

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